VISION 2000
OPERATIONS CONCEPT

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FOREWORD

The VISION 2000 Operations Concept Working Group intended this document to convey new principles for streamlining HST operations. It should be read with the understanding that the basic functional and operational requirements on the system are presumed unchanged unless challenged by these new inputs. It is therefore not a comprehensive specification, rather a guideline for change. It serves as the touchstone for evaluating the responsiveness of the re-engineered system architecture.

As a starting point for the concept development, issues and problems associated with HST operations were discussed, albeit at a high level. These became the pitfalls to be avoided if the overall concept were to be an improvement over the past. In passing, it should be noted that they probably represent a familiar litany, applicable to many other programs and endeavors. Although there is not a one-to-one correspondence between the issues and the conceptual tenets, hopefully a causal relationship should be obvious to the reader.

What did become clear to the Working Group is that any re-engineering would be far from complete, neither addressing the issues nor achieving the Project VISION 2000 goals, if management, system architecture and system development (and test) methodology were not also considered as well as the basic operations. Re-engineering, to succeed, needs to address the entire system. For this reason, the Working Group adopted an expanded definition of "operations" and subsequently developed requirements in these supporting areas as well. Finally, a new service area, entitled "Public Outreach", is introduced in order to fully address the stated Project VISION 2000 goals.

Introduction

The Operations Concept Working Group (OCWG) has been tasked to define the operational concept for a totally re-engineered HST program which is consistent with and strives toward the HST Operations & Ground System Project Vision 2000 goals . Its scope includes the following strategic areas, all fundamental to mission operations or in its direct support:

Operations
Architecture
Development
Management
Public Outreach

Strategic Objectives

The strategic objectives adopted by the OCWG, which amplify the Project Vision, are as follows:

HST shall :

- Reduce the cost of operations, including system development and maintenance, by the year 2000 by at least 50%. and continue to reduce costs thereafter through system and efficiency improvements in order to extend the mission lifetime.

- Be a technological leader in ground systems & flight systems for mission operations by employing state-of-art automation technologies and highly cost-effective implementation and management strategies.
  - Operational procedures & system design shall routinely result in zero defects & rework with zero risk for the flight system and very low risk for the science program. Corrective actions for defects are treated as exceptions rather than the rule.
  - Managers & operators are unessential for conducting routine operatio n
  - Configuration management adds zero wait time to the change process.

- Routinely achieve 100% user satisfaction by:

- Responding to Target of Opportunity observing requests within hours of the completion of the observational specification.
- Providing proposers with a complete set of tools to build a proposal with zero defects.
- Automatically updating proposals in event of changes
- Changing observing programs, without a decrease in science efficiency, within 18 hours for any one week and within 72 hours for a three week period.
- Commissioning new science instruments quickly

- Promote & accommodate an expanding observer base by increasing the exposure efficiency routinely to 50%

Concepts

In this section, operational concept changes are presented which attempt to address the issues and the strategic objectives described above. These are the drivers and requirements for the follow-on system architectural effort.

I. Architectural concepts:

1. The system architecture shall be organized into logical units independent of implementing or operating entities, contracts, or organizations.

2. Minimize cost and system perturbation by employing system architecture and design which can assimilate new requirements without the formalities, oversight, and overhead of major development efforts.

3. Eliminate functional duplications within the system and adopt standards for reference utilities such as models.

4. Introduce automation, where appropriate, to eliminate routine, repetitive operational procedures or functions.

5. Utilize autonomous techniques to perform continuous fault diagnostics of both the flight and ground systems on a continuous basis. Automatic failover shall be provided, where applicable, to minimize the need for human intervention and mission interruption.

6. Transfer functionality on-board in order that the spacecraft is able to operate its on-board systems with little or no ground control.

7. Safemode data shall be available via the HGA in order to expedite analysis and recovery.

8. Employ on-board data buffering, TDRSS "demand access", or the use of a modified form of generic scheduling - a communication opportunity template - to facilitate TDRSS-independent timelining for routine observations.

9. Streamline the scheduling and command generation process to become a single pass system, including self-checking and auto-diagnostic features.

10. Provide the capability for quickly interrupting the timeline, assuming the availability of the necessary communication links and science specification, in order to change the science observing program.

11. Quick and efficient access to all data by authorized users shall be provided without artificial complications imposed for security reasons.

II. Operations concepts

1. Baseline operation of the spacecraft by the system rather than manual intervention.

2. The Flight Operations Team (FOT), including the current MOR, PASSOPS, LOTTS, DOC and OPUS, shall be comprised of a small team of experts capable of responding to typical problems and authorized to alert larger support teams for more serious emergencies. Prevention of loss of a science observation shall not be a driver for staffing. Procedures, software tools and utilities shall be available for the FOT to intervene to ensure success of the observing program by protecting the next scheduled observation rather than rescuing the failed one.

3. The FOT shall be cross-trained to become skillful in analysis and testing techniques in order to better respond to emergencies, perform routine sustaining engineering tasks, and serve to accept (test) system changes.

4 Flight operations personnel shall become "knowledge" engineers with principle responsibility for maintaining and updating the rule base used for mission monitoring. The FOT shall be provided with a tool kit of mission operations support software to facilitate procedural, limit and data base changes without requiring action by maintenance or development organizations.

5. Routine generation of telemetry "plots" shall not be required. It shall be possible for the FOT to generate any such data as required to analyze faults or perform other sustaining engineering tasks. Autonomous trending alerts shall be provided to alert the FOT indicating dangerous changes in addition to limit violations. Staff shall be able to retrieve, decommute and subselect parameters required for analysis without the need for "middlemen"; tools shall provide easily used formats.

6. "Difficult" science programs, i.e., requiring significant manual intervention, or unusual operations, such as servicing mission support or major system upgrades, may require augmenting FOT staffing for brief periods.

7. Forward link communications shall be used primarily to update Stored Program Commands or, infrequently, the flight computer software; flight systems shall operate without the need for detailed ground intervention and the on-board computers shall maintain necessary reference tables, ephemerides, etc. .

8. Decouple communication requirements and minimize the impacts of TDRSS scheduling constraints, particularly for downlinking science data, from the timeline scheduling process.

9. Make safemodes "safer" for both the spacecraft and instruments, coupled with faster recovery, to minimize risk and facilitate a simplified form of ground system automation (along with reduced staffing).

10. All stored program commanding of HST shall be accomplished by a single schedule & command system which involves minimal manual intervention. Engineering proposals are to be handled along with science proposals ab initio eliminating the need for the current "merge" SMS. Interruption of SMS processing for decisions shall be necessary only when constraints are intentionally being violated. SMS duration shall be such as to optimize timeline interruptability and observational benefits while minimizing rework.

11. Only Science Instrument configuration modes certified through pre-launch testing shall be available for routine operations. New instruments shall conform while retro-fitting standardized sequences shall be accomplished before the year 2000 for existing ones. Instrument parameters, such as gain, wavelength, exposure, etc. for any given mode shall be easily selectable by observers or operators. Instrument selection criteria shall include operational cost.

12. The system shall be highly user-oriented enabling telescope users to have:

a) Easy guides and access to all information necessary to prepare valid proposals,

b) Tools for creating highly efficient, constraint-free observing requests,

c) Easy access to the status of their proposals during planning & execution.

13. Scheduling staff shall be primarily concerned with maximizing the science content of the observing schedule, not carrying out routine, procedural tasks. The scheduling system capabilities shall ensure that assembled schedules are legal and valid and not be rejected downstream. Completion of the command load generation for a one week period should be accomplished within one shift following receipt of the calendar.

14. Responsibility for scientific analysis lies with the observer. The system shall provide the observer with both raw and calibrated science data along with adequate, current calibration and engineering information to enable re-calibration by the observer if desired. Data will be delivered to or collected by the observer within 48 hours of executing the observation preferably by electronic means.

III. Development/maintenance methodology concepts:

1. The Mean Time To Repair for HST systems shall remain as current. System supporting health and safety of the mission shall have MTTRs in minutes to hours; for non-critical systems, hours to days.

2. Future system or subsystem designs shall be modular so as to allow several software modifications to proceed in parallel without interference and thus improve delivery. Designs shall include a straightforward backout capability so the system is more fault tolerant and easily "repaired". Software development methodology shall be purposeful and efficient rather than be driven by management or contractual specifications.

3. The local maintenance staff for any subsystem shall be authorized to make knowledge system upgrades and perform corrective system maintenance. This staff shall report directly to the operators, who control priorities. Testing shall be accomplished as an integral part of the maintenance.

4. Changes completely within a specific subsystem should be made and controlled by the local user-maintainer team associated with that subsystem, operating on a level of funding basis. Changes affecting multiple subsystems are controlled by either a cross-organization, functionally oriented working group; a project-wide system engineering board which oversees both space and ground assets; or upper management through the medium of the project long term development plan.

5. New developments (as opposed to subsystem maintenance) shall be led by an ad hoc team leader, selected by a management level steering group, who has the most vested interest in the development benefits. The leader shall have cross-organizational authority for all necessary resources, and establishes best estimate schedules for completion. Resources are negotiated with each individual organization involved.

6. Development shall involve the use of COTS and/or commercially available utilities to the maximum extent possible.

7. There shall be a "single" environment for each system, common to the developers, testers, and operational users. The same directory structures, file naming conventions, logical symbols, etc. shall be used. Automated testing, particularly for regression testing, shall be used to expedite release of capabilities. Self documentation of test results shall be employed to minimize wasted

effort. Test documentation is intended primarily for analysis, <u>not management reporting.</u> Independent testing shall not be employed; developers are responsible for testing as part of the development process. Testing shall be accomplished with the current version of the operational system; all special purpose simulators shall operate with the same operational system version. Multiple testing shall be avoided even for flight software development.

8. The Project Data Base shall be distributed with control residing with the primary users of the data base elements. Changes shall be handled by an immediate change process not subject to "build release" time constraints. A PDB office shall function only to control the procedures employed e.g. for change notification, documentation, etc.

9. CCBs, local to the logical subsystem elements and equivalent to the current Level IV CCBs , shall be used to control & monitor subsystem maintenance activities. A single project-wide CCB shall be used for all major developments and will control the Integrated Development Plan. Obsolescence plan for all subsystems shall be an integral part of the Integrated Development Plan.

10. Flight software installations shall utilize "non-intrusive" techniques to the greatest extent possible in order to minimize down time. Ground system software installations shall be made without affecting the observing timeline.

11. Only those documents vital to the operation and maintenance of the systems should be maintained.

IV. Management concepts:

1. The management structure shall be minimal. Government personnel shall manage performance and resources at the project level; contractors shall manage the accomplishment of assigned tasks including reallocation of resources within their area of responsibility. Government engineers may work with contractors in certain task areas to accomplish contractor assigned responsibilities. Management, in general, shall be by exception.

2. Performance assessment and award fee shall be based on quality-based metrics appropriate for the functional work being performed; milestone events shall normally be used only in development tasks. Metrics shall be defined and maintained for all development efforts which shall be the basis for reporting and performance assessment. Experience shall be exchanged across the project at an annual symposium.

3. The Integrated Development Plan (IDP) of VISION 2000 is the fundamental plan for all system development for all participating organizations. It can be changed, but only on a periodic basis, by means of a comprehensive review by users and experts, based on cost-benefit analyses. Major ground system changes needed to correct for flight subsystem failures will affect VISION 2000 and consequently will be incorporated as changes to the IDP. Servicing Mission system requirements are normally handled as maintenance level changes.

4. Local maintenance engineering teams shall participate in system management with responsibility for the overall coordination of subsystem changes. Reprioritization of maintenance tasks when more than one functional subsystem is affected shall be accomplished by this group; task direction and coordination shall be provided by an ad-hoc task leader selected by the maintenance teams. Functional subsystem configuration control is managed by the equivalent of Level IV CCBs.

5. Management operations shall avoid manually intensive procedures and rely on electronic information exchange for tracking technical development, operations, and financial status. Secretaries shall be replaced by information management specialists facile with computers and software applications who will serve as the local experts in these areas. Routine personnel documentation, such as performance assessments, position descriptions, travel requests, training requests, travel reports, etc. shall be entered directly into an electronic Management Information System by the person involved. Meetings will be used only for joint working discussions intended to result in technical or management decisions.

V. Outreach concepts:

1. Access and browse capabilities should be provided to the public for non-proprietary HST information including, images, system descriptions, science abstracts and press releases.

2. Detailed system descriptions and lessons learned shall be made available for use by engineering students and/or other mission developers. New technology and system enhancements shall be publicized.

3. Liaisons with educators shall be formed in order to provide materials for use in primary and secondary schools.

4. The HST simulators shall be accessible for use as test-beds in support of independent space engineering studies and research requiring validation or demonstrations involving representative flight missions.

5. HST facilities shall be made available, on an non-interference basis, for use by other missions in order to reduce the overall cost of NASA operation and development. In particular, provide the services of the Hubble Data Archive for use by short term, smaller science missions.

6. Support and manage the development of aerospace technology and research, applicable to enhancing the HST mission, through a series of grants for independent or joint research programs or studies.